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(72) Inventor PETER JOHN WILKINSON

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(54) ROTARY CONTROL VALVE

(71) We, NORTHERN ENGINEERING INDUSTRIES LIMITED, a British Company of Nei House, Regent Centre, Newcastle-upon-Tyne, NE3 3SB, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement: —

The invention relates to a rotary control valve.

The valve is particularly, though not exclusively, for use in burner apparatus having a recirculating spill tip shut-off atomiser.

According to the invention, a valve comprises a housing and a rotor rotatable in the housing, the housing having a cylindrical inner surface in which there are five ports lying in a plane normal to the rotational axis of the rotor and two end walls one of which has a central bore, the rotor being in sliding engagement with the surface and the walls of the housing and having a stub shaft extending from one end which passes through the bore in sealed engagement with the end wall, the rotor having, intermediate the ends of the rotor, two recesses lying in said plane, the surface of each recess together with said inner surface defining a flow path by which two adjacent ports can be interconnected, a first of the two portions of the surface of the rotor intermediate the recesses having a circumferential length such that, when two pairs of ports are interconnected by respective recesses, the remaining port is closed by said first portion.

Preferably, the ports are equi-angularly disposed around said axis.

Preferably, the parts of said inner surface of the housing intermediate adjacent ports each have a length equal to the length of a port, said lengths being measured along the circumference of a circle centred on said axis and formed by said cylindrical inner surface. Such lengths, and lengths on the rotor similarly determined, are hereinafter referred to as "circumferential lengths".

Preferably, said first portion of the rotor surface has a circumferential length greater than the circumferential length of a port but no greater than the sum of the circumferential length of a port and twice the circumferential length of a portion of said inner surface of the housing intermediate adjacent ports; the second of the two portions of the rotor surface having a circumferential length substantially equal to the circumferential length of a port.

Preferably, said recesses are arcuate when viewed in said plane, and are substantially U-shaped when viewed in a plane including said axis.

According to a further aspect of the invention, burner apparatus comprises a recirculating spill tip shut-off atomiser, a valve according to the first aspect of the invention, a pump whose input side is connectable to a fuel-oil supply means, a first conduit connecting a first inlet/outlet of the burner to a first of said ports, a second conduit connecting the output side of the pump to a second of said ports adjacent said first port, a third conduit connecting a second inlet/outlet of the burner to a third of said ports adjacent to said second port, a fourth and a fifth conduit connected to respective fourth and fifth of said ports adjacent to said third and fourth ports, respectively, the fourth and fifth conduits being connectable to the input side of the pump, and an automatic control valve, responsive to operating demand on the apparatus, being located in whichever of said fourth and fifth conduits fuel oil flows when the atomiser is firing during use of the apparatus.

Preferably, the apparatus comprises more than one atomiser and valve. In this instance the pump output can be connected to the second port of each valve; whichever of the fourth and fifth conduits in which the automatic control valve is not located has a flow restrictor located therein.

The fourth and fifth conduit can be combined into a single conduit downstream of the automatic control valve.

Preferably, the fourth and fifth conduits are connected to an input conduit of the pump. Alternatively, the fourth and fifth conduits are connectable to the input side of the pump through the fuel-oil supply means.

A valve, and a burner apparatus incorporating the valve will now be described by way of example only with reference to the accompanying drawings, of which:—

Figure 1 is a diagrammatic cross-sectional view of a valve in accordance with the invention in a first operating position;

Figure 2 is a view similar to Figure 1 but showing the valve in a second operating position;

Figure 3 is a diagrammatic sketch of a burner apparatus incorporating the valve of Figures 1 and 2;

Figure 4 is a partial perspective view, partly in section, of a modified rotor for a valve in accordance with the invention; and

Figures 5 and 6 are views similar to Figures 1 and 2, respectively, but showing modified valves.

A valve 10 has a housing 12 and a rotor 14. The housing 12 consists of a tubular casing 16, having a cylindrical inner surface 18, and two end walls.

The casing 16 has five ports 20 disposed symmetrically around the casing 16 in a plane normal to the rotational axis 22 of the rotor 14. The ports 20 each comprise an aperture having counter-bore 24 and 26, the inner bore 24 being of smaller diameter than the outer bore 26.

The portions 28 of the surface 18 intermediate the ports 20 each have a circumferential length equal to the circumferential length of each of the inner ends of the inner bore 24 of the ports 20.

The end walls of two cover plates 29 (only one shown—see Figure 3) secured to the ends of the casing 16 for example by bolts *29a*.

The cover plates 29 can be relieved to provide a central raised locating portion which locates within the casing 16.

One cover plate 29 has a central bore *29b* through which extends a stub shaft 30 (see Figure 4) of the rotor 14. The stub shaft 30 is in sealing engagement with the central bore, for example by means of an O-ring seal.

The rotor 14 has, in the plane of the ports 20 and intermediate the ends of the rotor 14, two recesses 32 (symmetrically disposed with respect to the axis 22). The recesses 32 are arcuate when viewed in said plane (Figures 1 and 2) and are substantially U-shaped when viewed in a plane including the axis 22 as can be ascertained from Figure 4.

A first portion 34 of the surface of the rotor 14 intermediate the recesses 32 has a circumferential length equal to the sum of the circumferential length of the inner end of the inner bore 24 of a port 20 and twice the circumferential length of one of the portions 28 of the surface 18. A second portion 36 of the surface of the rotor 14 intermediate the recesses 32 has a circumferential length equal to the circumferential length of the inner end of the inner bore 24 of a port 20.

The end (not shown) of the stub shaft 30 is polygonal in section, for example square, so that it can be engaged by a complementary key or a spanner by which the rotor is turned.

Alternatively, an actuator 100 (see Figure 3) can be used to operate the valve 10. The actuator 100 is preferably a compressed air actuated actuator. In situations where the valve has to be fail safe, the return action of the actuator 100 is spring controlled. Suitable actuators are available from, for example, Kinetrol Limited, Surrey, U.K.

The valve 10 in Figures 1 and 2 is shown as having conduits seated in the ports 20. This is to facilitate the main description of Figure 3 below and the conduits and the respective ports are numbered according to that description.

In Figure 3, burner apparatus 50 for use in a boiler (not shown) may have several fuel oil atomisers, only one of which is shown at 52, a valve 10 (as shown in Figures 1 and 2) associated with each atomiser 52, an automatic boiler control valve 54 of a type known *per se* associated with atomisers 52 and a pump 56 for feeding fuel oil to each of the atomisers 52.

The atomisers 52 are of the recirculating spill tip shut-off type and each have a body 60 in which there are first and second inlet/outlet ports 62 and 64, respectively, at one end of flow passages 66, 68 in the body 60 (indicated by dotted flow lines). The passages 66, 68 are interconnected at their others ends by an atomising nozzle 70. A lance 69 is mounted in the body for movement axially within the body. The lance is biased so that its tip closes the nozzle 70 and is movable by fuel oil pressure against the bias to open the nozzle 70.

The pump 56 has an inlet conduit 72 from a fuel oil reservoir 75. The fuel oil can be pre-heated in a well known manner by a heater 77 interposed into the conduit 72. A further heater is also provided in conduit 76.

Each atomiser 52 is connected to the pump 56 in the manner described below.

The first port 62 of the atomiser 52 is connected by a conduit 74 to a first port 20A of the valve 10. The pump 56 is connected by a conduit 76 to a second port 20B of the valve 10 adjacent to port 20A. The second port 64 of the atomiser 52 is connected by a conduit 78 to a third port

20C of the valve 10 adjacent to port 20B. A conduit 80 connects a fourth port 20D of the valve adjacent to port 20C, to the inlet conduit 72 of the pump 56; the conduit 80 has the control valve 54 interposed therein to control flow of fuel oil through the conduit 80. A conduit 82 connects a fifth port 20E of the valve 10, adjacent to port 20D, to the conduit downstream of the valve 54; the conduit 82 has a flow restrictor indicated at 84.

Each valve 10 has a compressed air actuated-spring-returned actuator 100. The actuator 100 is supplied with compressed air along supply line 102 which has a control valve 104 therein. The valve 104 is operated by signals in line 106 from a burner control unit 108. The actuator 100 also has a vent line controlled by a control valve 110 which is operable by signals in line 112 from the unit 108.

The atomising flow or non-atomising flow status of the valve 10 is indicated in the burner control unit 108 by limit switches 114, 116 connected to the unit by lines 118, 120, respectively.

The burner control unit 108 is also responsive to other conventional safety interlock signals generated within the boiler control system and these functions are indicated by lines 122, 124, 126 connected to the unit 108. Typically, line 126 is shown connected to an ignition/flame monitoring probe indicated at 128.

The actuator 100 is spring-returned since the burner 52 has to be fail safe, i.e. the burner must shut down on failure of the compressed air supply.

When the boiler is being operated the valves 10 are in the position shown in Figure 2, the fuel oil flowing in the direction shown by the arrows and arrowheads in Figures 2 and 3. The flow of fuel oil through each atomiser 52 is controlled by the associated control valve 54, controlled by signals in line 55 from the boiler control system, which increases or decreases line pressure according to the demand on the boiler.

If it is required to shut off one atomiser 52 completely, the valve 10 associated with that atomiser 52 is turned by the actuator 100, through the unit 108, to the position shown in Figure 1, all the ports 20A to 20E being shut off from one another at the change-over point. In the position shown in Figure 1, the flow of fuel oil through the atomiser 52 is reversed causing the lance of the atomiser 52 to move to shut off the nozzle 70. The flow of fuel oil through the atomiser 52 keeps the atomiser 52 relatively cool. In the position shown in Figure 1, the fuel oil returns to the input side of the pump 56 through conduit 82. The restrictor 84 prevents excessive fluctuation in the line pressure provided by the pump to the other atomisers 52.

Typically, the operating pressure is around 4.2 MN/m^2 and the temperature of the fuel oil is 130°C.

The valve 10 described above is compact and has very simple flow paths through it as compared to spool-type or rotary valves typically used previously. The shape of the recesses 32 and the ports 20 and the manner in which the recesses 32 align with the ports 20 contribute to minimising the resistance to flow of fuel oil through the valve 10. The alignment of the recesses 32 with the ports 20 enables the circumferential lengths of the portions 34 and 36 of the rotor surface to be at a maximum to afford long leakage paths and so minimise leakage between the ports 20, although in this particular application of the valve 10 some leakage can be tolerated.

Modifications (not shown) can be made to the embodiment shown in Figure 3. For example, the conduit 82 could extend directly to the conduit 72. Also, the conduits 80 and 82 could extend into the fuel oil reservoir instead of to the conduit 72. However, this latter construction is not preferred since any heat in the fuel oil would be lost to the reservoir whereas in the construction shown heat is conserved and only the minimum of pre-heating is required for the fresh fuel oil.

Also, if the atomiser 52 operated in the reverse sense to that shown, the conduit 82 would have the control valve 54 and the conduit 80 would have the restrictor 84.

The apparatus described with reference to Figure 3, is also applicable where only a single atomiser 52 is used in some applications. In this instance the restrictor 84 would not necessarily be required.

If leakage is found to be unacceptable, for example owing to high operating temperatures necessitating greater manufacturing tolerances in the valve parts, the rotor 14 can be provided with seals as shown in Figure 4. The portion 34 of the rotor surface has two seals positioned so as to be either side of a port 20 which it is closing off. The portion 36 of the rotor surface has one such seal.

The seals shown in Figure 4 each have a strip 90 located in a recess 92 extending parallel to the axis 22. The strip 90 is biased radially outwardly by, for example, coil springs 94 located in radially-extending blind bores 96 (only one of which is shown).

In an alternative construction of the seal, the recess 92 is radially deeper than the radial dimension of the strip 90 and a strip of corrugated spring steel is positioned in the base of the recess.

It has also been found that in a test of the valve 10, under the typical operating

conditions described above, has an operating torque for switch-over in the region of 50Nm. It is not certain why this torque arises but it was noted that resistance to movement of the rotor 14 was initially low and then increased.

In the embodiment shown in Figure 5, the valve rotor 14 is provided with a Y-shaped bore 130 lying in the plane of the ports 20. The leg of the bore 130 connects the portion 36 of the surface of the rotor 14 through the arms of the bore 130 to the portion 34 of the surface of the rotor 14 on either side of the port 20 being closed by the rotor 14. It was found that with this construction the operating torque dedecreased by approximately 50%. This allows a smaller, and therefore less expensive, actuator to be employed.

An alternative construction is shown in Figure 6 in which the valve rotor 14 has a straight through-bore 132 interconnecting the portions 34 and 36 of the surface of the rotor 14.

WHAT WE CLAIM IS:—

1. A valve comprising a housing and a rotor rotatable in the housing, the housing having a cylindrical inner surface in which there are five ports lying in a plane normal to the rotational axis of the rotor and two end walls one of which has a central bore, the rotor being in sliding engagement with the surface and the walls of the housing and having a stub shaft extending from one end which passes through the bore in sealed engagement with the end wall, the rotor having, intermediate the ends of the rotor, two recesses lying in said plane, the surface of each recess together with said inner surface defining a flow path by which two adjacent ports can be interconnected, a first of the two portions of the surface of the rotor intermediate the recesses having a circumferential length such that, when two pairs of ports are interconnected by respective recesses, the remaining port is closed by said first portion.

2. A valve according to Claim 1, in which the ports are equi-angularly disposed around said axis.

3. A valve according to Claim 1 or 2, in which the parts of said inner surface of the housing intermediate adjacent ports each has a circumferential length equal to the circumferential length of a port.

4. A valve according to any preceding Claim, in which said first portion of the rotor surface has a circumferential length greater than the circumferential length of a port but no greater than the circumferential length of a port and twice the circumferential length of a portion of said inner surface of the housing intermediate adjacent ports.

5. A valve according to any preceding claim, in which the second of the two portions of the rotor surface has a circumferential length substantially equal to the circumferential length of a port.

6. A valve according to any preceding claim, in which said recesses are arcuate when viewed in said plane, and are substantially U-shaped when viewed in a plane including said axis.

7. A valve according to any preceding claim, in which the first and second portions of the rotor surface have seals which are resiliently biased outwardly into contact with said inner surface of the housing.

8. A valve according to any preceding claim, in which the first and second portions of the rotor surface are interconnected by a bore extending through the rotor between said portions.

9. A valve according to Claim 8, in which the bore is Y-shaped, the leg of the bore opening onto the second portion and the arms of the bore opening onto the first portion, the circumferential length between the ends of the arms of the bore being greater than the circumferential length of a port.

10. A valve according to Claim 8, in which the bore is a straight through-bore.

11. Burner apparatus comprising a recirculating spill tip shut-off atomiser, a valve as claimed in any preceding claim, a pump whose input side is connectable to a fuel-oil supply means, a first conduit connecting a first inlet/outlet of the burner to a first of said ports, a second conduit connecting the output side of the pump to a second of said ports adjacent said first port, a third conduit connecting a second inlet/outlet of the burner to a third of said ports adjacent to said first port, a third conduit connecting a second inlet/outlet of the burner to a third of said ports adjacent to said second port, a fourth and a fifth conduit connected to respective fourth and fifth of said ports adjacent to said third and fourth ports, respectively, the fourth and fifth conduits being connectable to the input side of the pump, and an automatic control valve, responsive to operating demand on the apparatus, being located in whichever of said fourth and fifth conduits fuel oil flows when the atomiser is firing during use of the apparatus.

12. Apparatus according to Claim 11, in which there are more than one atomiser and associated valve.

13. Apparatus according to Claim 12, in which the pump output is connected to the second port of each valve, whichever of said fourth and fifth conduits in which the automatic control valve is not located having a flow restrictor located therein.

14. Apparatus according to any claim of

Claims 11 to 13, in which the or each valve has a compressed air operated-spring return actuator for rotating the rotor thereof.

15. A valve according to Claim 1, substantially as hereinbefore described with reference to any of the accompanying drawings.

16. Burner apparatus according to Claim 11, substantially as hereinbefore described with reference to any of the accompanying drawings.

ROBERT J. CUMMINGS,
Chartered Patent Agent.
Agent for the Applicants.

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Fig.1.

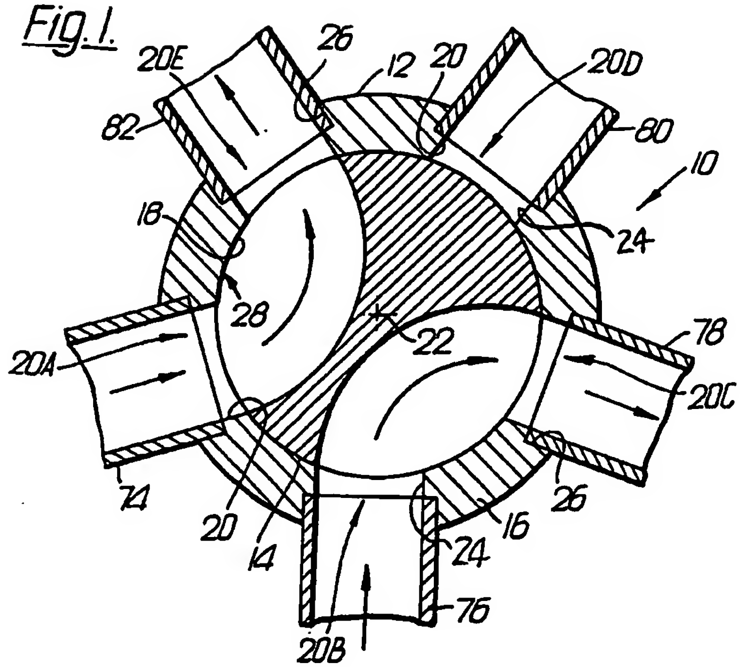
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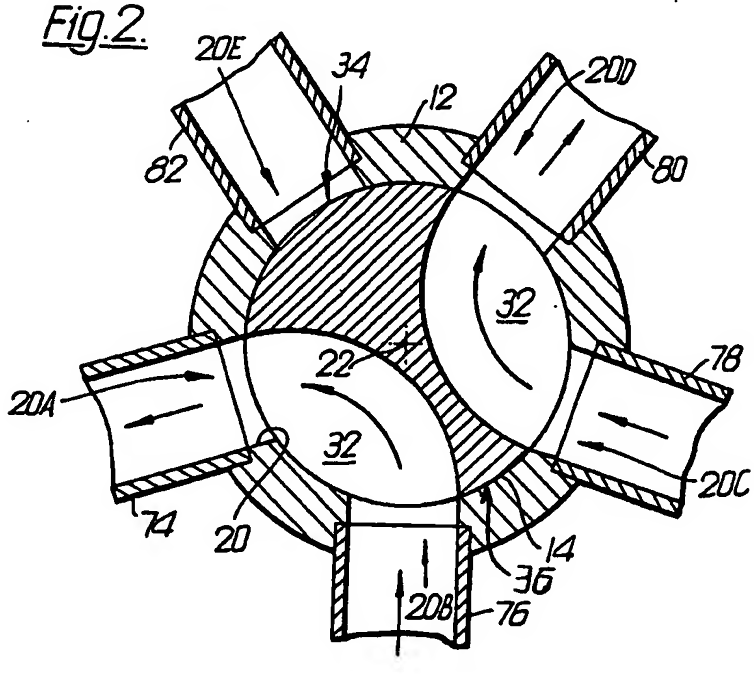
Fig.2.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SHEET 2

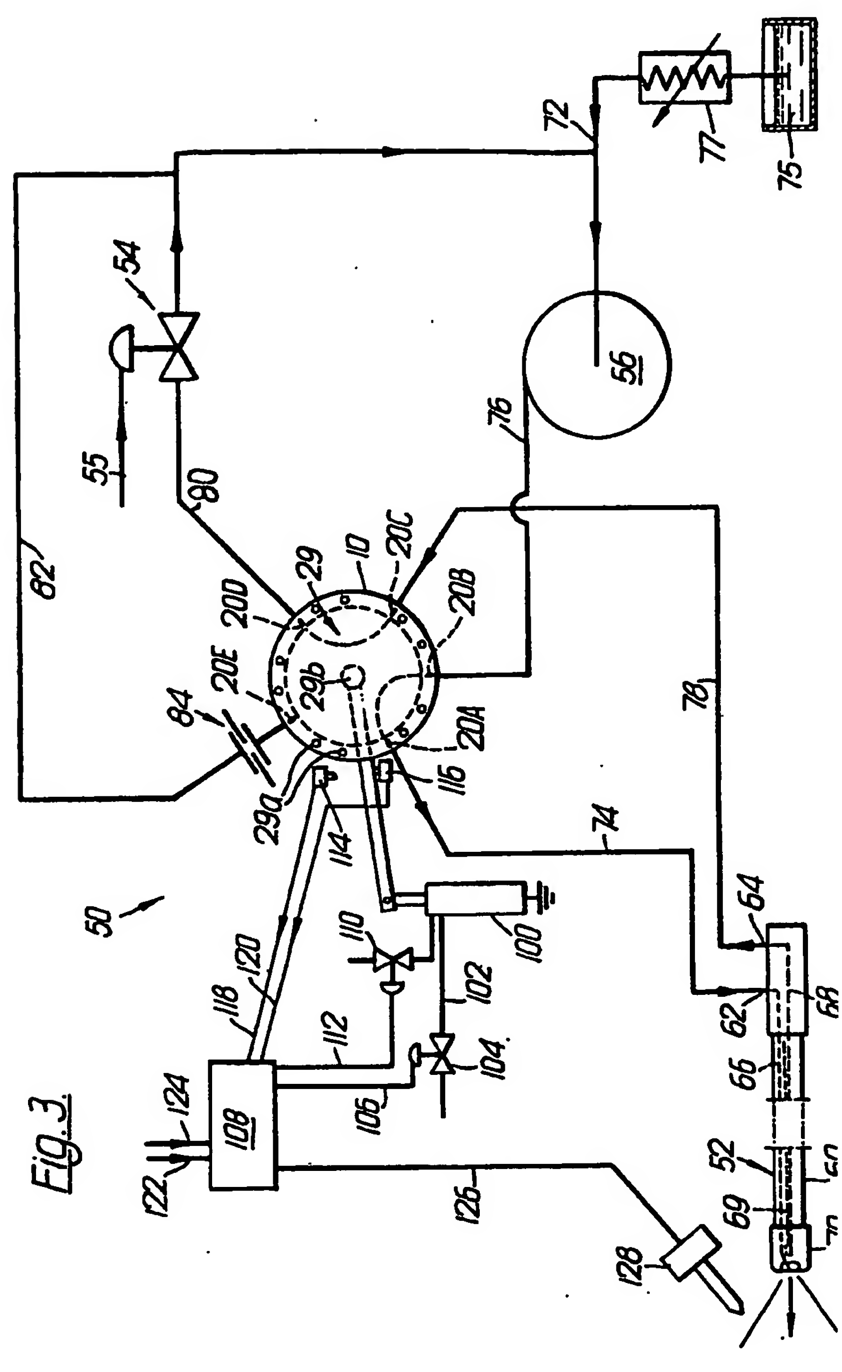

Fig.3

Fig.4.

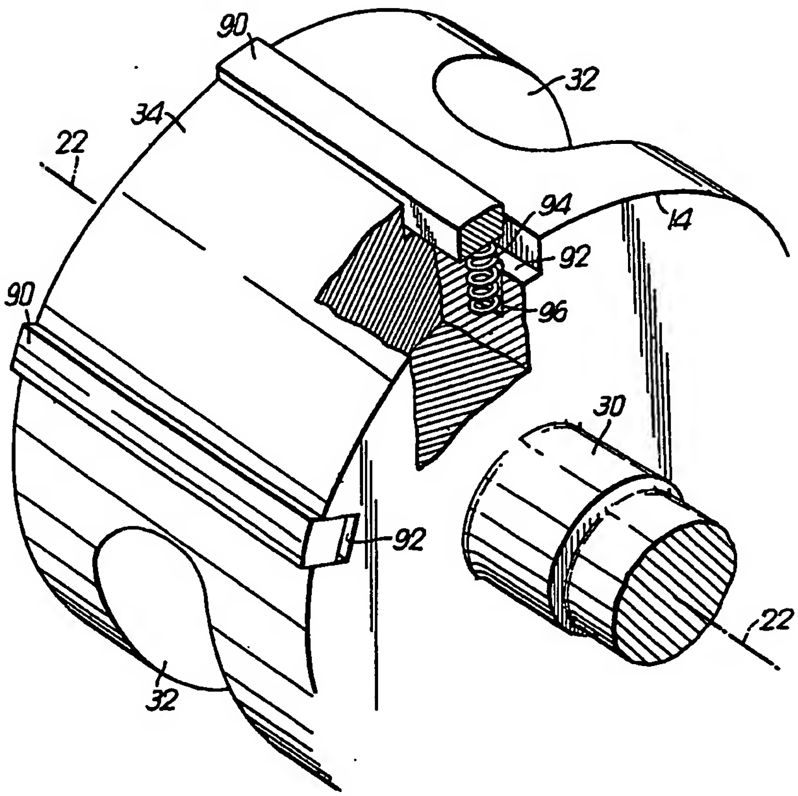

Fig. 5.

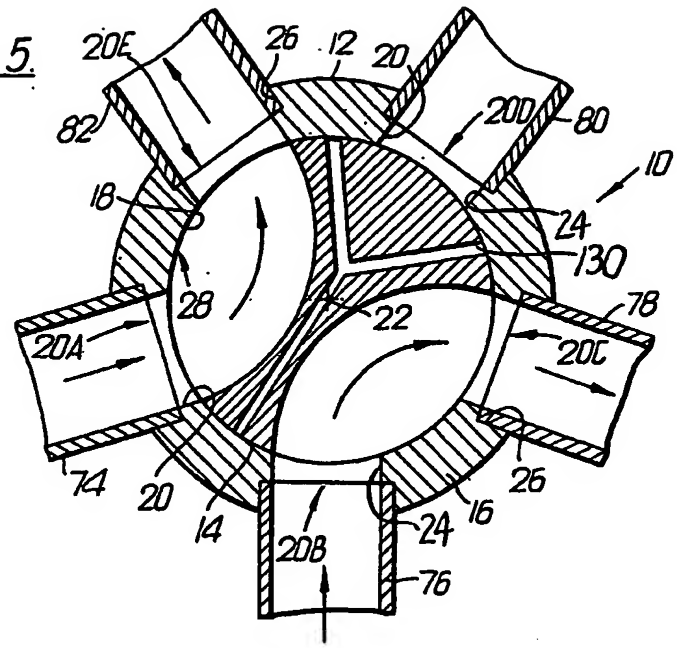
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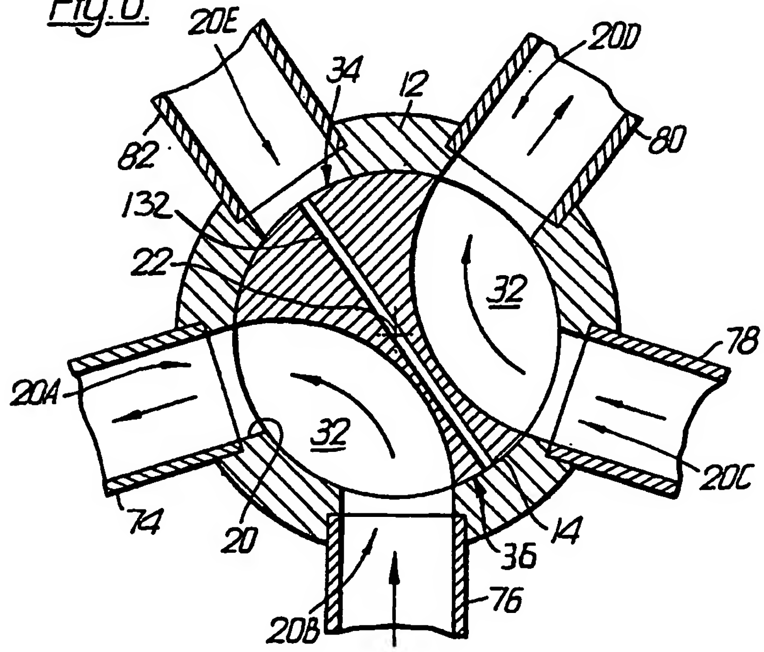
Fig. 6.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